P2003-103624 (April 08, 2003, Japan)

[Name of Document] Description

[Title of the Invention] POLISHING PAD AND METHOD OF POLISHING A WORK MATERIAL BY USING THE SAME

[CLAIMS]

[Claim 1]

A polishing pad allowing optical detection of its polishing end point during polishing of the surface of a work material, comprising a substantially non-foam resin containing an organic fiber in an amount of 1 to 20 wt%, having the pad surface functioning to transport and hold polishing slurry particles in a state where the organic fiber is exposed during polishing operation, and allowing transmission of a light at a wavelength in the range of 190 to 3,500 nm.

[Claim 2]

A polishing pad allowing optical detection of its polishing end point during polishing of the surface of a work material, comprising a region made of a substantially non-foam resin containing an organic fiber in an amount of 1 to 20 wt%, having the surface in this region in contact with the work material during polishing operation that functions to transport and hold polishing slurry particles in a state where the organic fiber is exposed, and allowing transmission of a light at a wavelength in the range of 190 to 3,500 nm.

[Claim 3]

The polishing pad according to Claim 1 or 2, wherein the

organic fiber is an aramide fiber.

[Claim 4]

A polishing method of polishing a work material, comprising optically detecting its polishing end point by using the polishing pad according to any one of Claims 1 to 3.

[Claim 5]

The polishing method of polishing a work material according to Claim 4, further comprising pressing the work material surface to be polished to the organic-fiber-exposed surface of the polishing pad, supplying a polishing slurry between the work material and the pad, and sliding the work material and the pad relatively to each other.

[Detailed Description of the Invention]

[0001]

[Technical Field to Which the Invention Belongs]

The present invention relates to a polishing pad used in polishing the surface of a work material, and a production method thereof, and in particular, to a polishing pad used together with a CMP (Chemical Mechanical Polishing) polishing slurry in production of semiconductor devices, that is suitable for use in the steps of the polishing by irradiating light on the semiconductor wafer surface though a polishing pad, detecting the change in reflectance, and thus, controlling the polishing end point such as formation of a shallow trench separation, flattening of interlayer insulation film, and metal wiring by damascene method. The present invention also relates to a polishing method of polishing a work material by using the

polishing pad.

[0002]

[Prior Art]

In the current tread toward increase in packaging density of ultra-large-scale integrated circuit, various microfabrication technologies are now under research and development. The design rule is already in the sub-half micron order. One of the technologies under development for satisfying the strict requirements in microfabrication is CMP (chemical mechanical polishing) technology. The technology is effective in flattening the layer to be exposed to light completely, alleviating the load of exposure technology, and stabilizing the production yield at a high level in the processes for manufacturing semiconductor devices, and the polishing is performed in the following way. The film on the surface of a work material is removed precisely to a predetermined thickness, by pressing the work material to a polishing pad and sliding the polishing pad and the work material relatively to each other, while a CMP polishing slurry solution is supplied between the work material and the polishing pad.

[0003]

An example of the CMP method in the semiconductor device production process is a recess CMP technique of removing undesired regions of the film embedded in trenches, for example, during device separation, generation of memory capacitor, plug and embedded metal wiring, and others. A LOCOS (local oxidation of silicon) technology has been used for device separation in

an integrated circuit, but, along with the trend toward increase in processing definition, a shallow trench separation technique, more superior in device separation, is used increasingly. During the shallow trench separation, the CMP technique is needed for removal of the additional silicon oxide film embedded in a substrate. Although Al wire has been used first in the wiring process, currently, embedded wiring by the dual damascene process, which uses Cu, a metal lower in resistivity, as the wiring metal, is the mainstream process. In the damascene method, the CMP technique is essential for removing the Cu wiring plated on a substrate surface. Further, it is necessary to control the polishing degree adequately during CMP polishing in the shallow trench isolation step, the damascene metal-wiring polishing step, and the interlayer insulating film-polishing step. Examples of the control methods include strict control of polishing period, detection of the change in torque of the motor driving the polishing machine due to the change in the friction between pad and wafer during polishing, and measurement of the electrostatic capacity of the work material. However, there are more polishing machines having a sensor for optically detecting the change in wafer surface state during polishing available recently, and a technology of controlling the wafer polishing state by irradiating a laser beam or infrared ray from a polishing machine via a polishing pad onto the polishing surface of a wafer and detecting the reflected beam once again via the polishing pad by a sensor in the polishing machine is becoming predominantly popular. The optical method is useful especially in the shallow

trench isolation step and the dual damascene method, because a barrier film is exposed on the wafer surface at the end of polishing and a high reflectance can be obtained if a light with a suitable wavelength is used for detection. In the step of polishing an insulation film having no barrier film, it is possible to detect the polishing degree from the interference between the reflected beam from wafer surface and the reflected beam from the silicon layer beneath insulation film. A polishing pad of a formed polyurethane resin plate having a transparent window allowing transmission of light formed in part thereof is used as a typical example of the polishing pad using such an optical method. Also proposed are methods of making a polishing pad of a non-form resin, such as polyurethane, polycarbonate, nylon, acrylic polymer or polyester, transmit light (see, for example, Patent Document 1). However, these polishing pads demand optical detection of end point as well as reduction of polishing scratch during CMP polishing and preservation of polishing speed, and in particular in the damascene, as described above it is important to reduce generation of the defects caused by polishing scratch and corrosion, because the metal more chemically reactive and softer than the interlayer insulation film.

[0004]

[Patent Document 1] U.S. Patent No. 5605760

[0005]

[Problems to be Solved by the Invention]

In polishing and flattening the surface of

shallow-trench-separation insulation film, Cu wiring film, or other work materials, or in forming an embedded layer, the work material is polished by rotation of the polishing pad, while a CMP polishing slurry is supplied between it and the polishing pad; and a method of irradiating a light via the polishing pad to the surface of the wafer during polishing, detecting the reflected light, and controlling the polishing end point is becoming a technique of choice recently. An object of the invention is to provide a polishing pad allowing transmission of a light for detection of wafer polishing state and restricting generation of the polishing scratch on the work material during such polishing. Another object of the invention is to provide a polishing method of polishing a work material by connecting the polishing pad to a polishing machine, performing polishing, and detecting the polishing end point.

[0006]

[Means for Solving the Problems]

The present invention relates to a polishing pad allowing optical detection of its polishing end point during polishing of the surface of a work material, comprising a substantially non-foam resin containing an organic fiber in an amount of 1 to 20 wt%, having the pad surface functioning to transport and hold polishing slurry particles in a state where the organic fiber is exposed during polishing operation, and allowing transmission of a light at a wavelength in the range of 190 to 3,500 nm.

[0007]

The present invention also relates to a polishing pad allowing optical detection of its polishing end point during polishing of the surface of a work material, comprising a region made of a substantially non-foam resin containing an organic fiber in an amount of 1 to 20 wt%, having the surface in this region in contact with the work material during polishing operation that functions to transport and hold polishing slurry particles in a state where the organic fiber is exposed, and allowing transmission of a light at a wavelength in the range of 190 to 3,500 nm.

[0008]

The present invention also relates to a polishing method of polishing a work material, comprising optically detecting its polishing end point by using the polishing pad.

In the polishing pad according to the present invention, the organic fiber exposed on the surface relaxes the stress between the polishing particles /foreign materials in the polishing slurry and the work material during polishing and prevents scratching of the work material surface. Although cavities and trenches in different width on the surface are responsible for transportation and holding of the polishing particle of polishing slurry in conventional polishing pads made only of a common resin, the organic fiber exposed on the surface is capable of transporting and holding the polishing particle and plays a role to obtain high polishing speed and to improve its uniformity of the polishing pad according to the present invention.

[0009]

The polishing pad according to the present invention, or part of it, transmits a light at a wavelength in the range of 190 to 3,500 nm, and thus, it is possible to control the polishing end point by irradiating the light onto the work-material polishing surface and detecting the change in reflectance. In the invention, transmission of a light at a wavelength in the range of 190 to 3,500 nm normally means that polishing pad, or part of it, before exposure of the organic fiber has a transmission coefficient of the light at the wavelength of 10 to 100%. The transmission coefficient is preferably 30 to 100%.

[0010]

[Mode for Carrying out the Invention]

As described above, in polishing a work material, the polishing pad according to the invention detects its polishing degree optically, controls its end point, and prevents generation of polishing scratch during polishing, while preserving its high polishing speed and uniformity. Such a polishing pad is only realized by determining the structure, resin composition, filler material, and others properly of the polishing pad in the following manner:

[0011]

The polishing pad according to the present invention has a structure in which the organic fiber is exposed on the working-material-sided surface at least during use, and the material for the polishing pad is transparent to a light at a wavelength in the range of 190 to 3,500 nm, or part of the polishing

pad is made of the material transparent to the light. The latter structure is prepared, for example, by dividing a polishing pad part into a small piece and putting it into another insufficiently transparent polishing pad as a window for light transmission.

A relatively high-modulus thermosetting or thermoplastic resin is used as the matrix resin for holding the fiber in the polishing pad according to the present invention. In particular, the hardened product preferably has a room-temperature elastic modulus of 0.1 GPa or more, more preferably 0.5 GPa or more. A resin with a smaller elastic modulus may give a polishing pad poorer in flatness. Examples of the thermoplastic resins include polycarbonate, polymethyl methacrylate, AS (acrylonitrile-styrene copolymers), ABS (acrylonitrile-butadiene rubber-styrene copolymers), polyethylene, polypropylene, polybutene, 4-methyl-pentene-1, ethylene-propylene copolymers, ethylene vinyl acetate copolymers, polyester, polyamide, polyamide-imide, polyacetal and the like. These resins may be used alone or in combination of two or more, and in particular, and a semicrystalline thermoplastic polymer, if used as the matrix resin, gives a polishing pad superior in abrasion resistance and higher in durability.

[0012]

Examples of the thermosetting resins include epoxy resins such as bisphenol A epoxy resin and cresol novolak epoxy resin, unsaturated polyester resins, and the like. When an epoxy resin is used as the thermosetting resin, it is usually blended with

a curing agent, a curing accelerator, and the like. Examples of the curing agents for use include dicyandiamide, organic acids, organic acid anhydrides, polyamines, and the like, and examples of the accelerators include 2-ethyl-4-methylimidazole and the like.

The resin is preferably in the form substantially free from formed air bubble holes. It is because a resin containing the formed holes inhibits light transmission and detection of polishing state.

[0013]

A fibrous material such as of aramide, polyester, or polyimide is used as the organic fiber. Two or more of the fibrous materials may be used in combination as selected properly. Preferably an aramide fiber is selected as a single or major component. It is because the aramide fiber, which is higher in tensile strength than other common organic fibers and thus remains on the surface in a greater amount when the surface of the polishing pad according to the present invention is roughened mechanically for exposure of the fiber, is effective . In addition, use of it also improves the durability of the polishing pad and elongates its lifetime during use.

[0014]

There are two kinds of aramide fibers, para- and meta-aramide fibers, but the para-aramide fiber is more preferable, as it is higher in dynamic strength and lower in hygroscopicity than the meta-aramide fiber. A commercially available products, poly-p-phenylene terephthalamide fiber or

poly-p-phenylene diphenylether terephthalamide fiber, may be used as the para-aramide fiber. The fiber diameter (diameter) of the organic fiber is 1 mm or less, preferably 200 μm or less, preferably 1 to 200 μm, more preferably 5 to 150 μm. The fiber length is 10 mm or less, preferably 5 mm or less, and more preferably 0.1 to 3 mm. An excessively shorter length may lead to lack of maintaining effectively the exposed fibers from the pad when the pad surface is roughened mechanically, while an excessively longer length may make molding of a mixture of a resin and the fiber difficult because of the increase in viscosity of the mixture. It is possible to use the short fibers chopped to a particular length, or to use a mixture of several short fibers different in length.

In addition, the fiber surface may be previously roughened mechanically or chemicallyor modified, for example, with a coupling agent for improvement in compatibility with the resin. Bundles of chopped short fibers adhered to each other with an extremely small amount of resin may be used for convenience in handling. However, the resin for adhesion is added in such an amount that the short fiber is easily dispersed in the matrix resin by the heat or the shearing force applied during agitation with the matrix resin.

[0015]

The content of the organic fiber should be in the range not inhibiting light transmission and allowing detection of the wafer polishing state. It is thus 1 to 20 wt%, preferably 2 to 10 wt%, in the entire polishing pad. A smaller fiber content

leads to distinctive polishing scratches on the polishing surface, while an excessively larger content to deterioration in moldability.

[0016]

The method of producing the resin composition for the polishing pad according to the present invention is not particularly limited, and any one of known methods may be used. For example, respective matrix-forming components are mixed (dry blended), for example, in a Henschel mixer, a super mixer, a tumble mixer, or a ribbon blender uniformly, and the mixture is melt-extruded, for example, from a single screw extruder, a twin screw extruder, or a Banbury mixer. An organic fiber is mixed additionally with the resins above in the molten state, and the mixture is cooled and tabletized. The tablet should be dehydrated thoroughly by drying, if water is used for cooling. A final sheet-shaped molding is prepared by extruding the tablets of the thermoplastic resin composition through a dice from an injection molding machine and rolling the resulting sheet. The thickness of the plate material is preferably 0.1 to 5 mm, more preferably 0.5 to 2 mm. The plate material is cut into a polishing pad in the predetermined shape (e.g., circular shape) corresponding to the shape of the polishing table of polishing machine, or is cut into a small piece and inserted into a hole in other polishing pad lower in light transmission as an optically transparent window, to give a polishing pad allowing optical detection. Preferably in the latter case, a polishing pad lower in light transmission having a hole for insertion of the window

is also made of a resin plate containing an organic fiber, to enhance the advantageous effects of the present invention, but the fiber content is not particularly limited. The window inserted should be in contact with the work material on the pad surface during polishing. It is because, if the window and the work material are significantly separated in space from each other, the polishing slurry may flow into the space and inhibit optical detection by scattering the transmitted light. The shape of the window is not particularly limited, but the size thereof should be large enough to ensure an optical path allowing proper operation of the photoirradiator/detector sensor system placed in the polishing machine for optical detection, and the window preferably has an area of approximately 0.1 to 10% with respect to the entire surface of the polishing pad surface.

Concentric or lattice-shaped grooves may be formed on the polishing surface of the polishing pad, for example, by using a NC lathe.

[0017]

In the invention, one of the methods for exposing the fiber on the polishing pad surface is dressing treatment, a method of exposing the fiber by scraping off the pad surface by using a whetstone such as diamond powder. Other material such as resin brush, or ceramic plate may be used instead of the whetstone, but it is preferable to prevent fractions of the tool formed by abrasion during machining from remaining on the pad surface. The usable length of the organic fiber in the region exposed on the surface is 1 mm or less, but preferably 200 μm or less,

more preferably 1 to 200 μm, and still more preferably 10 to 150 μm. Shorter length leads to deterioration of the retaining stability of the polishing particles and thus in decrease of polishing speed, while longer length to adverse effects on flatness. The polishing pad may be bonded to the rear face of the polishing table of polishing machine by using an adhesive such as double-faced adhesive tape.

[0018]

In the polishing method of polishing a work material according to the present invention, the polishing end point is detected optically by using the polishing pad according to the present invention. The polishing is performed, for example, by pressing the polishing surface of a work material to the organic fiber-exposed surface of the polishing pad, supplying a polishing slurry between the work material and the pad, sliding the work material and the pad relatively to each other, and thus polishing the polishing surface of the work material.

Hereinafter, a method of polishing a substrate by using the polishing pad according to the present invention, an embodiment of the polishing method according to the present invention, will be described.

[0019]

For example, a substrate obtained by preparing the pattern of a device with a silicon nitride film, etching the Si-exposed region, forming a silicon oxide film thereon for example by TEOS-plasma CVD is used as the polishing substrate in the shallow trench separation step, while a substrate obtained by preparing

an interlayer insulation film on which viaholes and trenches are formed by dry etching, forming a barrier film completely covering the openings and internal walls, and forming a Cu film completely filling the openings additionally thereon, in the damascene method.

[0020]

The polishing pad according to the present invention controls polishing end point in the polishing machine for accurate polishing of the film, by detecting exposure of the silicon nitride film in the shallow trench separation step or the barrier film in the damascene method by reflection of the light irradiated onto the wafer surface. A program for controlling the progress of polishing is installed previously into the polishing machine.

The CMP polishing slurry for use in the present invention is not particularly limited, but examples of the polishing slurries for polishing an insulation film such as of silicon oxide include polishing particles such as of silica and ceria, and examples of the polishing slurries for a metal film such as of Cu include polishing particles such as of silica, alumina, ceria, titania, zirconia and germania and polishing slurries containing an additive, an anticorrosive and a peroxide dispersed in water. The content of the polishing particles is preferably 0.1 to 20 wt%. The polishing particles may be prepared in any way, but the average diameter is preferably 0.01 to 1 μm. A polishing particles having an average diameter of less than 0.01 μm leads to decrease in polishing speed, while that of more than

1.0 μm causes an increased number of scratches.

[0021]

The polishing machine should have devices for irradiation of a laser beam and detection of the reflected beam that are placed on the polishing table for connection to the polishing pad, as in the MIRRA polishing machine manufactured by Applied Materials U.S. The polishing condition is not particularly limited, but is preferably optimized according to the polishing work material. During polishing, the polishing slurry is supplied to the polishing pad continuously, for example, by a pump. The feed rate is not limited, but the surface of the polishing pad is preferably covered always with the polishing slurry. The fiber exposed on the pad surface is regenerated and maintained after polishing of semiconductor substrate, as it is subjected to dressing with a pad conditioner described above attached to the polishing machine.

The work material after polishing is preferably washed thoroughly with running water and dried after the water drops on the polishing surface are removed, for example, by using a spin dryer.

[0022]

[Example]

Hereinafter, the present invention will be described in detail with reference to Examples, but it should be understood that the present invention is not restricted by these Examples.

The following plate materials 1 to 3 were prepared for preparation of the polishing pads in Examples and Comparative

Examples of the present invention.

[0023]

[Plate material 1]

An organic fiber, poly-p-phenylene terephthalamide fiber (trade name "Kevlar", manufactured by Dupont, fiber diameter: 12.5 μm, fiber length: 3 mm) and a matrix composition, AS resin pellet (trade name: Litac A-100PC, manufactured by Nippon A&L Inc.) were melt-blended and tabletized in an extrusion molding machine. The content of the poly-p-phenylene terephthalamide fiber was adjusted to 5 wt%. The tablet obtained was dried in a large-sized dryer at 120°C for 5 hours, and then processed into a sheet-shaped molding of 1.2 mm in thickness and 1 m in width by using an extrusion molding machine and a roll.

[0024]

[Plate material 2]

AS resin pellet (ditto) was melt-extruded from an extrusion molding machine into tablets. The tablets were dried in a large-scale drier at 120°C for 5 hours, and then, processed into a sheet-shaped molded product having a thickness of 1.2 mm and a width of 1 m by extrusion molding and rolling. The plate material contained no organic fiber.

[0025]

[Plate material 3]

A chopped para-aramide fiber ("Kevlar", manufactured by DuPont, fiber diameter: 12.5 μm, fiber length: 5 mm), a para-aramide fiber pulp ("Kevlar", manufactured by DuPont, fiber diameter: 1 μm, fiber length: 1 mm), and a chopped meta-aramide

fiber ("Conex", manufactured by Teijin Ltd., fiber diameter: 25 μm, fiber length: 6 mm, softening temperature: 280°C) were blended; an aqueous solution of 20 wt% water-soluble epoxy resin binder (trade name: "V Coat", manufactured by Dainippon Ink and Chemicals, Inc., glass transition temperature: 110°C) was sprayed thereon and the mixture was dried by heating (150°C, 3 min); and the mixture was heat-compressed between a pair of heated rolls (temperature: 300°C, linear pressure: 196 kN/m), to give a nonwoven fabric wherein the chopped meta-aramide fiber was fused thermally to the chopped para-aramide fiber. The basis weight was 70 g/m^2, and the ratio of chopped para-aramide fiber/para-aramide fiber pulp/chopped meta-aramide fiber/epoxy resin binder was 58/17/8/17 by weight.

[0026]

A bisphenol A epoxy resin (trade name: "EP-828SK", manufactured by Yuka Shell Epoxy K.K.) varnish containing a curing agent dicyandiamide and an accelerator 2-ethyl-4-methylimidazole was prepared. For preparation of the varnish, 20 parts by weight of the curing agent, 0.1 wt part of the accelerator, and 40 parts by weight of a solvent methylethylketone were used with respect to 100 parts by weight of the bisphenol A epoxy resin.

[0027]

The varnish was impregnated to the aramide fiber nonwoven fabric described above, and the mixture was dried under heat (170°C, 5 min), to give a prepreg. The amount of the resin added was adjusted in such a manner that the prepreg after

high-temperature high-pressure molding had a thickness of 0.08 mm. The content of the aramide fiber nonwoven fabric was 60 wt%.

[0028]

A laminated plate having a thickness of 1.0 mm was obtained by piling twelve prepreg layers together with two release films (polypropylene film of 50 μm in thickness) at both ends, holding the pile between two mirror-surfaced stainless steel plates placing multiple sets thereof via two thickness cushion material of 10 mm in thickness made of multiple Kraft paper layers in a hot press, and molding them at high temperature and high pressure (temperature: 170°C, pressure: 300 kPa, period: 120 min).

[0029]

Example 1

The plate material 1 was processed into circular disks having a diameter of ϕ500 mm; a trench was formed on the surface to make the polishing slurry supplied during polishing flow under the jig holding the wafer to below the wafer (lattice-shaped, groove width: 2 mm, groove pitch: 15 mm, groove depth: 0.6 mm); a double-faced tape was bonded to the rear face; and the composite was used as a polishing pad.

[0030]

Example 2

The plate material 1 was cut into rectangular disk-shaped small pieces of 56 mm in length and 19 mm in width with rounded edges (curvature radius: 1.0 mm). Then, the plate material 3 was cut into a circular disc of ϕ500 mm in a similar manner to

Example 3, and grooves were formed on the surface thereof. A hole in the rectangular disk shape of 56 mm in length and 19 mm in width with rounded edges was formed at a position halfway from the center of the circular disc to the circumference in the radial direction, in the manner that the longitudinal direction of the hole represents the radial direction. The small piece in the rectangular disk shape described above of plate material 1 was inserted to the circular disc hole as a window for transmitting light for optical detection. Finally, a double-sided adhesive tape was adhered to the face opposite to the face where the trenches were formed, to give a polishing pad.

[0031]

Conventional Example 1

A commercially available polishing pad of a formed polyurethane resin, having a light transmission window of a transparent resin plate for optical detection in a rectangular disk shape of 56 mm in length and 19 mm in width with sharp edges, was made available (thickness 1.2 mm, "IC-1000/Suba-400", manufactured by Rodel Inc.,).

[0032]

Comparative Example 1

A polishing pad was prepared by processing of the plate material 2 in a similar manner to Example 1.

[0033]

Comparative Example 2

A polishing pad was prepared by processing of the plate

material 3 in a similar manner to Example 1. The polishing pad does not have a window, differently from that in Example 2.

[0034]

By using each of the polishing pads and the CMP polishing slurries obtained in these Examples, Conventional Examples and Comparative Examples, a silicon wafer (blanket wafer or TEG wafer described below) was polished in the following manner.

Before the polishing experiment, the light transmission of the polishing pads obtained in the Examples, the Conventional Example, the Reference Example and the Comparative Example was determined. A polishing pad having a light transmission window was tested by using the window, while a polishing pad without it was tested by using the plate material of the polishing pad main body. The transmission coefficient was determined at a measurement wavelength of 670 nm by using a spectrophotometer UV-2200 manufactured by Shimadzu Corp. The measured value was converted to a transmission coefficient of a plate of 1 mm in thickness, by using the Lambert-Beer's law.

[0035]

The polishing pads were adhered to the polishing table of ϕ500 mm of the MIRRA manufactured by Applied Materials U.S. used as the polishing machine. As for polishing pads having a light transmission window for optical detection, the window of the polishing pad was connected firmly to the window of the polishing table of polishing machine. Each polishing pad, after connected to the polishing table, was subjected to dressing at 9LB for 15 minutes, as a diamond dresser manufactured by Asahi

Diamond Industrial Co., Ltd. (dressing particles: #170, acryl coated) is connected to the pad conditioner mechanism in the polishing machine. Observation of the surface state of each polishing pad revealed that the fiber is exposed on the surface of the polishing pads of Example 1 and Comparative Example 2 (exposure length: approximately 500 μm). The fiber was exposed (exposure length: approximately 500 μm) similarly on the window as well as on the entire surface of the polishing pad of Example 2. Exposure of the fiber was not observed on the polishing pads of Conventional Example 1 and Comparative Example 1.

The structure, the surface state and the light transmission of the polishing pads of the Examples, the Conventional Example, the Comparative Example and the Comparative Example are summarized in Table 1.

[0036]

[Table 1]

	Structure	Presence of window
Example 1	AS resin plate containing aramide fiber	No
Example 2	Epoxy resin plate containing aramide fiber	Yes (material of Example 1)
Conventional Example 1	Formed polyurethane resin plate (two-layered)	Yes
Comparative Example 1	AS resin plate	No

Comparative Example 2	Epoxy resin plate containing aramide fiber	No

	Light transmittance (%)	Surface state
Example 1	49.1	Fiber exposed
Example 2	49.1	Fiber exposed
Conventional Example 1	67.2	Fiber unexposed
Comparative Example 1	94.5	Fiber unexposed
Comparative Example 2	3.6	Fiber exposed

[0037]

As described above, by using the polishing pad obtained in each Example and the CMP polishing slurry, Conventional Example or Comparative Example placed in the polishing machine, a silicon wafer (blanket wafer or TEG wafer described below) was polished in the following manner, and the properties were evaluated from the viewpoints below. The evaluation results are summarized in Table 2.

[0038]

Number of polishing scratches:

A blanket wafer having a silicon oxide film of 1 μm in thickness formed on a ϕ200 mm silicon wafer by the TEOS-plasma CVD method is placed in a polishing machine. The wafer is then held by the head unit and the silicon oxide film side is brought

into contact with the polishing pad on the polishing table. The silicon oxide film on wafer is polished for 1 minute under a polishing pressure applied on the wafer surface during polishing set to 21 kPa (3 PSI) while supplying a cerium oxide-based polishing slurry (HS-8005, manufactured by Hitachi Chemical Co., Ltd.) at a feed rate 40 mL/min and an additive (HS-8102GP, manufactured by Hitachi Chemical Co., Ltd.) at a feed rate of 160 mL/min as they are mixed dropwise onto the polishing table and rotating the polishing table at 100 rpm and the head at 90 rpm. The silicon wafer after polishing is washed thoroughly with purified water and dried, and then, the entire surface of the wafer is observed in dark field under a microscope and the number of the polishing scratches was counted.

[0039]

Polishing speed:

The thickness of the silicon oxide film on each blanket wafer after evaluation of the number of polishing scratches is determined by using a light-interference thickness analyzer, and an average polishing speed is determined from the difference from the thickness of silicon oxide film determined before polishing.

[0040]

Uniformity:

The polishing speeds of the silicon oxide film at various point on each blanket wafer face were determined in a similar manner to the measurement of polishing speed, and the variations (1S/average polishing speed ×100) in polishing speed was

calculated from the standard deviation (1δ).

[0041]

End point management:

A pattern of lines having width and gap respectively of 25 to 2,000 μm was made of a silicon nitride film having a thickness of 100 nm on a ϕ200 mm silicon wafer; the Si exposed area was etched to a depth of 350 nm; and a silicon oxide film was formed on the wafer by the TEOS-plasma CVD method on the wafer to a thickness of 600 nm, to give a TEG wafer having an irregularity of 450 nm on the surface. Before polishing the wafer under the same condition as the blanket wafer described above, it was judged whether it is possible to detect exposure of the silicon nitride film, by using the ISRM laser-beam end point-managing system attached to the polishing machine used for evaluation.

[0042]

Flatness:

After detecting the exposure of silicon nitride film by the end point management system described above, the difference in surface level between the line (width 100 μm) of the silicon nitride film on the TEG wafer after polishing and the line of the neighboring silicon oxide film (width 300 μm) was determined by using a stylus profilometer Dektak3030 (manufactured by SLOAN).

[0043]

[Table 2]

	Polishing speed (nm/min)	Uniformity (%)	Scratch (number/wafer)

Example 1	280	3	3
Example 2	290	5	5
Conventional Example 1	180	5	30
Comparative Example 1	210	12	55
Comparative Example 2	310	5	5

	End point management	Flatness (nm)
Example 1	Possible	20
Example 2	Possible	25
Conventional Example 1	Possible	20
Comparative Example 1	Possible	20
Comparative Example 2	Impossible	-

[0044]

The results of examples 1 and 2 in Table 2 show that use of the polishing pad according to the invention allows management of the end point by optical detection, and comparison of the results with that of Conventional Example 1 and Comparative Example 1 shows that it is possible to suppress generation of polishing scratches by the action of the organic fiber. It was

also confirmed that the polishing speed was higher and the uniformity was also sufficiently high. The polishing pad of Comparative Example 2 did not show a sufficiently distinctive change in reflectance allowing detection of the end point by photoirradiation during polishing of the TEG wafer evaluated. It corresponds to the fact that the polishing pad of Comparative Example 2 showed low light transmittance in the earlier experiment.

[0045]

The polishing pads obtained in Examples of the present invention allow end point control when used in polishing a metal film, for example, by the damascene method, and also reliable polishing while preventing generation of polishing scratch.

[0046]

[Effect of the Invention]

As described above, it is possible by using the polishing pad according to the invention to control the end point of polishing a work material in a polishing machine having an optical system of detecting the polishing state of work material and also, to prevent scratching caused by polishing of the work material, with the organic fiber exposed on the surface. It is thus possible to improve the productivity for and the yield of the work material.

[Name of Document] Abstract

[Abstract]

[Object] To provided a polishing pad allowing transmission of a light for optical detection of wafer polishing state and restricting generation of the polishing scratch on the work material during polishing.

[Solving Means] A polishing pad allowing optical detection of its polishing end point during polishing of the surface of a work material, comprising a substantially non-foam resin containing an organic fiber in an amount of 1 to 20 wt%, having the pad surface functioning to transport and hold polishing slurry particles in a state where the organic fiber is exposed during polishing operation, and allowing transmission of a light at a wavelength in the range of 190 to 3,500 nm, and a method of polishing a work material, comprising pressing the polishing surface of a work material to the organic fiber-exposed surface of the polishing pad, supplying a polishing slurry between the work material and the pad, sliding the work material and the pad relatively to each other.

[Selected Figure] None